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STUDY OF AIR QUALITY ON KATRAJ CHOWK TO NAVALE BRIDGE: THE OLD DEHU KATRAJ STRETCH

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Abstract

Pune is an important city in the state of Maharashtra. The city is situated in the western part of Maharashtra on the banks of two rivers, Mula and Mutha and is the administrative headquarters of Pune district. Air quality parameters in the vicinity area of Katraj chowk to Navale was select, for study and it is found that the concentration of PM10 is more in all the three months i.e. January, February and March and at all the locations selected. However, the concentration of PM2.5, SO2 and NO2 is within the limits of the standards given by Central Pollution Control Board. It is found that the concentration of PM10 is due the re-suspension of the particulate matter on the roads due to the dryness in the atmosphere. The problem of re-suspension of the particulate matter is observed less in rainy season as compared to the winter and summer.

***Key Words*:** Pune, air quality, *PM10, PM2.5, SO2 and NO2*

1. INTRODUCTION

Exposure to outdoor air pollution is related with 3.2 million early deaths globally and is among the top ten health risks worldwide. Motorized transportation is a major source of outdoor air pollution, particularly in highly urbanized areas in developed and emerging regions. Exposure to traffic-related emissions is associated with asthma onset in children, impaired lung function, cardiovascular disease, and premature. The impact of global air pollution on climate and the environment is a new concern in atmospheric science. Intercontinental transport and hemispheric air pollution by ozone endangers agricultural and natural ecosystems worldwide and have a strong effect on climate. International initiatives to reduce global air pollution require participation from both developed and developing countries. Air pollution is the process of fusion and diffusion into the atmosphere of chemicals, particulates, or biological materials that cause discomfort, disease, or death to humans, damage other living organisms such as food crops, or damage the natural environment or built environment. A substance in the air that can be adverse to humans and the environment is known as an air pollutant. Pollutants can be solid particles, liquid droplets, or gases. In addition, they may be natural or man-made. Pollutants can be classified as primary or secondary. Usually, primary pollutants are directly produced from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulphur dioxide released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone – one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary: that is, they are both emitted directly and formed from other primary pollutants. Ambient air pollution has been identified as a national problem since it is the fifth biggest cause of mortality in

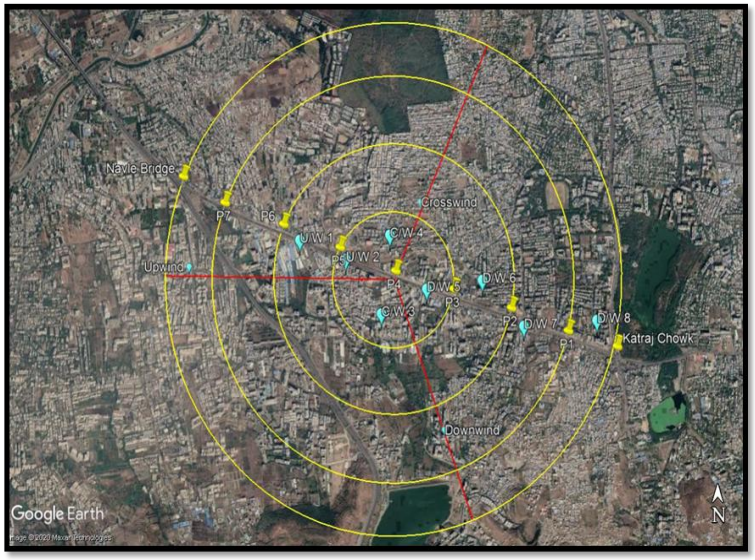
India. Central Pollution Control Board (CPCB) in India implements the National Air Quality Monitoring Programme through a network comprising 544 operating ambient air quality stations covering 224 cities/towns in 26 states and 5 union territories of the country. Under NAMP three major pollutants viz. PM10 (Particulate Matter having an aerodynamic diameter less than or equal to 10 µm), Sulphur dioxide (SO2) and Nitrogen dioxide (NO2) have been identified for regular monitoring at all locations.

1.1 Problem Statement

As per the data of Regional transport office Pune region from the year 2016-2017 to 2017-2018 total no. of vehicles registered in Pune city increases by 10.7%. Increase in vehicles due to migration of people from sub-urban and urban area due to employment opportunities. 'Navale bridge' to 'Katraj chowk' is the major road of about 3.8 kms connecting highway and other major adjoining job sector areas. Due to this, heavy congestion in the areas ultimately expose the people in such areas to pollutants released from the vehicles. Long term and continuous exposure ultimately leads to several air-borne related health issues as also affecting the surroundings.

2. METHODOLOGY

As per the data of Regional transport office Pune region from the year 2016-2017 to 2017-2018 total no. of vehicles registered in Pune city increases by 10.7%. Generally, the standard limits of the outdoor air pollutants is set by the Central Pollution Control Board. But due to heavy vehicle transportation and traffic congestion in this particular area of study, the intensity of the pollutants is more and can be understood is above the set standard of limits; which leads to health issues in humans and effects on environment. This study will address the major air pollutants and its consequences due to exposure on humans as well as surroundings.



This is the Google image of the study area from Katraj Chowk to Navale Bridge. The plotting and selection of the locations to be monitored is done on this map based on the wind directions in the particular months when monitoring was carried out. The monitoring of the selected locations is basically in the upwind and crosswind directions.

A. Number and Distribution of Monitoring Locations:

Knowledge of existing air pollutants levels and pattern within the area are essential for deciding number and distribution of stations. Isopleths distribution of an ambient concentrations determined from modeling or previous air quality information can be used to determine number and distribution of stations. When isopleths maps are not available information of emission densities and land use pattern may be used with wind rose data to determine areas of expected higher concentrations. The number of monitoring stations in a city can be selected based on background information collected on sources and emissions, Population figures which can be used as indicators of region variability of the pollutants concentration.

The no. of sampling sites depends on;

- Size of the area to be covered
- The variability of pollutant concentration over the area to be covered
- The data requirements, which are related to the monitoring
- Pollutant to be monitored and
- Population figures which can be used as indicators of criticality both from view of likely air quality deterioration as also health implications.

B. Selection of Monitoring Location:

Principal factors governing the locations of the sampling stations are the objectives, the particular method of instrument used for sampling, resources available, physical access and security against loss and tampering. Air quality monitoring should be done in areas where pollution problem exists or is expected i.e. mainly in industrial areas, urban areas, traffic intersections etc. One of the objective of monitoring is to determine status and trends and the air quality monitoring should be done in metropolitan cities and other urban areas so as to compare their levels and determine trends. Selection of site is very important as an incorrect location may result in data that may not meet the objectives of monitoring and will be of limited value.

C. Selection of Pollutants:

Prior to selection of pollutants, an emission inventory study or modeling results can be carried out or used if available. The pollutants expected from the sources present should be monitored. For monitoring in metropolitan cities and urban areas, the common urban air pollutants such as carbon monoxide, SO_2, NO_2, SPM and RSPM should be measured on a regular basis. Resource availability can play a very important role in determining the pollutants to be measured in an area. If enough resources are available then monitoring of specific parameters such as Polycyclic Aromatic Hydrocarbons (PAHs), ozone etc. can also be carried out.

The pollutant selection criteria is as follows:

Criteria for SO_2 Measurements

Sources of SO_2 include domestic emissions from fossil fuel burning, industrial emissions and diesel vehicles. The station should be located where populations are large and where pollution levels are high. Actual number of stations in any specific area depends on local factors such as meteorology, topography, resources available etc.

Criteria for NO_2 Measurements

NO_2 is formed in the atmosphere by reaction of nitric oxide (NO) with ozone and hydrocarbons (HC). Thus high NO_2 levels are expected at locations where NO, ozone and hydrocarbons levels are high. Generally areas with high population and traffic are chosen for measuring NO_2. Since ozone is formed downwind from the sources, NO_2 levels downwind from the sources can also be high provided NO is also present in sufficient quantity.

Criteria for RSPM/PM_{10} Measurements

One of the major sources of RSPM are vehicles especially diesel vehicles. Site for measuring RSPM should be located where number of such vehicle are high. Industrial sources such as combustion processes also contribute to ambient RSPM levels and

RSPM measurements should also be conducted near such industrial activities.

Criteria for SPM Measurements

The major sources of SPM include soil borne dust, dust originating from construction activities, resuspension of dust etc. In general the site for selecting stations for SPM should be located at areas where vehicle density is high and where high levels of SPM are expected.

Criteria for CO Measurements

CO is emitted from vehicles and its measurement should be conducted near traffic intersections, highways, commercial areas with high traffic density. Generally areas with high population density also have high vehicles and higher CO levels and these areas should also be considered for conducting CO measurements.

D. Sampling Duration and Frequency:

The period and frequency of sampling should be such that statistically reliable averages can be obtained with the data. National Ambient Air Quality Standards states that annual average should be computed of 104 measurements taken twice a week of 24 hours duration. One of the objective of monitoring under NAMP is to determine compliance to the NAAQS so monitoring should be done for 24 hours and minimum 104 days in a year.

The pollutants vary diurnally and seasonally and these variations should be taken into account for determining frequency of sampling. The precision required in the data is also important in determining frequency of sampling. Sampling should be more frequent than the frequency of variation of pollutants.

Particulate matter levels are lower during the monsoon months due to removal by wet deposition. Air pollutants such as CO levels are higher during winter months due to lower mixing heights resulting in less volume of troposphere available for mixing and hence higher concentrations. Thus measurements should be conducted in all the seasons so that in annual average all the seasons are represented equally. In general minimum 20% of the reading should be taken in each season.

E. Measurement Methods:

NAAQS states the measurement methods for various pollutants. These methods should be used for conducting ambient air quality measurements. Selecting the method among the various options depend upon the resources available to sustain the measurement over a long time, detection limit of the methods, degree of skill required etc. Automatic analysers are often costly and need skilled manpower to operate them. Measurement of pollutants by wet

chemical methods is fairly simple. The detection limit of the method should be lower than the expected concentrations in an area.

Instruments used for the air quality monitoring should be easy to use, calibrate and require minimum maintenance. Automatic analysers are costly and require skilled calibration parameters change. Measurement of Sulphur dioxide (SO_2), and Nitrogen dioxide (NO_2) by wet chemical method is fairly simple and can be employed easily in India. High Volume Sampler is being widely used for particulate matter measurement in India.

F. Meteorological Measurements:

Meteorology plays a significant role in study of air pollution and it is necessary to measure meteorological parameters. The essential meteorological parameters that should be measured are wind speed and direction, ambient air temperature, relative humidity, rainfall, atmospheric pressure and mixing height. Details of the meteorological instrument and method of measurement is given in Annexure – II. Anemometer is used to measure velocity of air, wind vane is used to measure wind direction, precipitation gauge or rain gauge is to measure rainfall and precipitation, thermometer is used to measure temperature, dry and wet bulb hygrometers, sling psychrometers is used to measure humidity in the air. SODAR is used to measure mixing height.

The wind data i.e. speed, direction and intensity are graphically represented by a diagram called wind rose diagram. Humidity is measured in terms of Relative Humidity which is the percentage of moisture present in the air, complete saturation being taken as 100. The greater the "RH" more the air is saturated. The RH below 30% is also unpleasant which can cause, drying of mucous, soar throat and cough. Moisture indicates the potentiality for fog formation in relation to the degree of air pollution.

$PM_{2.5}$ low volume samplers are similar to the PM_{10} high volume samplers in that they also have a size selective inlet, a filter, and a means of pulling air through the system; however, the $PM_{2.5}$ samplers have some unique characteristics. The size selective inlet is comprised of two separate size selective inlets: the first is a PM_{10} inlet to remove all the larger particulates followed by a $PM_{2.5}$ selective inlet to exclude the particulates greater in diameter than 2.5µm. The large glass fiber filter used in PM_{10} instrumentation is replaced by a 47 mm diameter Teflon filter. $PM_{2.5}$ filters are used mainly for particulate mass determinations and not characterizations as are the larger PM_{10} filters. Particulate characterization is still done in conjunction with $PM_{2.5}$, but species specific traps such as denuders, foam plugs, cation and anion exchangers, absorbents, etc., are used. Most $PM_{2.5}$ samplers are under microprocessor control that uses real time temperature and barometric pressure readings to determine the actual flow rate, not estimations as with PM_{10} flow rate determinations. Due in large part to the smaller filter and lower flow rates, $PM_{2.5}$ samplers can be equipped with a variety of size selective inlets. The smaller filter used in $PM_{2.5}$ samplers allows for advanced automation whereby a filter can be used and a replacement filter automatically put into position for another sampling period. In addition, $PM_{2.5}$ samplers can be equipped with an automatic weighing system for continuous real time analysis.

3. Result discussion

Based on the monitoring done with the Fine Dust Sampler instrument, following values of major air pollutants are obtained:

A. Month: January 2020

	Parameters			
Location	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**NO_2**
A1	125.23	34.78	28.49	35.76
A2	119.86	31.02	26.75	33.1
A3	131.33	34.26	33.3	41.29
A4	105.73	28.51	25.92	30.14
A5	112.36	30.82	27.15	36.05
A6	117.66	32.26	28.43	37.17
A7	129.57	35.21	29.25	36.89
A8	123.85	30.26	32.84	40.12

In the month of January 2020, the PM_{10} concentration was above 100µg/m^3 for the duration of 24 hours on all the monitored locations; whereas $PM_{2.5}$ concentration was below 60µg/m^3. Also, the concentration of SO_2 and NO_2 pollutants is below 80µg/m^3 for the 24 hours duration.

B. Month: February 2020

	Parameters			
Location	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**NO_2**
A1	121.86	32.16	24.82	29.84
A2	119.36	29.21	27.15	35.75
A3	108.66	24.36	26.78	34.13
A4	135.23	34.17	28.2	47.49
A5	128.36	33.95	25.15	39.24
A6	121.56	30.28	27.05	33.15
A7	118.32	28.1	30.85	39.52
A8	134.86	34.02	32.94	42.84

In the month of February 2020, the PM_{10} concentration was above 100µg/m^3 for the duration of 24 hours on all the monitored locations; whereas $PM_{2.5}$ concentration was below 60µg/m^3. Also, the concentration of SO_2 and NO_2 pollutants is below 80µg/m^3 for the 24 hours duration.

C. Month: March 2020

	Parameters			
Location	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**NO_2**
A1	118.33	30.58	21.43	30.15
A2	115.86	28.41	27.53	33.78
A3	105.23	20.27	20.2	28.44
A4	107.35	24.12	21.75	32.72

A5	121.36	31.23	24.51	32.59
A6	125.23	33.78	29.84	38.41
A7	119.66	29.29	28.32	40.89
A8	112.32	25.71	23.49	35.7

In the month of March 2020, the PM_{10} concentration was above 100µg/m^3 for the duration of 24 hours on all the monitored locations; whereas $PM_{2.5}$ concentration was below 60µg/m^3. Also, the concentration of SO_2 and NO_2 pollutants is below 80µg/m^3 for the 24 hours duration.

3. CONCLUSIONS

From the above measured parameters in the vicinity area of Katraj chowk to Navale bridge, it is found that the concentration of PM_{10} is more in all the three months i.e. January, February and March and at all the locations selected. However, the concentration of $PM_{2.5,}$ SO_2 and NO_2 is within the limits of the standards given by Central Pollution Control Board. It is found that the concentration of PM_{10} is due the re-suspension of the particulate matter on the roads due to the dryness in the atmosphere. The problem of re-suspension of the particulate matter is observed less in rainy season as compared to the winter and summer time.

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